MATERIAL SAFETY DATA SHEET

1. SUBSTANCE AND SOURCE IDENTIFICATION

National Institute of Standards and Technology
Standard Reference Materials Program
100 Bureau Drive, Stop 2300
Gaithersburg, Maryland 20899-2300

SRM Number: 2841
MSDS Number: 2841
SRM Name: Semiconductor Thin Film: $Al_xGa_{1-x}As$ Epitaxial Layers

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Description: Standard Reference Material (SRM) 2841 is intended for use as a reference standard for analytical methods that measure the composition of thin films, such as electron microphobe analysis (EMPA), photoluminescence (PL), auger electron spectroscopy (AES), and X-ray photoelectron spectroscopy (XPS). SRM 2841 consists of an epitaxial layer of $Al_xGa_{1-x}As$ with certified Al mole fraction *x* grown on a GaAs substrate. A unit of SRM 2841 consists of the semiconductor region mounted to a stainless steal disk by the use of adhesive tape and sealed in a Mylar envelop containing a nitrogen atmosphere.

Substance: GaAs/AlGaAs ($Al_xGa_{1-x}As$) semiconductor

2. COMPOSITION AND INFORMATION ON HAZARDOUS INGREDIENTS

Component[(a)]	CAS Number	EC Number (EINECS)	Nominal Concentration (% by weight)
GaAs	1303-00-0	215-114-8	99.3 %

[(a)] Hazardous components 1 % or greater; Carcinogens 0.1 % or greater are listed in compliance with OSHA 29 CFR 1910.1200.

EC Classification (assigned): T, N
EC Risk (R): 23, 25, 51, 53
EC Safety (S): 20, 21, 22, 28, 41, 45

Other components:

Carbon Double-Sided Adhesive Tape
Not considered hazardous under normal usage.

Stainless Steel Disk (1.52 g)
Not considered hazardous under normal usage.

3. HAZARDS IDENTIFICATION

Potential Health Effects

Skin Contact: Acute exposure of inorganic arsenic compounds may be irritating to the skin. Some absorption may occur mainly through damaged skin. Sensitization dermatitis may also occur. Chronic exposure to airborne inorganic arsenic compounds may cause burning and itching to the skin and also result in dermatitis.

Eye Contact: Acute exposure or repeated or prolonged exposure of inorganic arsenic compounds may cause irritation and conjunctivitis with itching, burning, lacrimation, and photophobia.

Inhalation: Acute exposure of inorganic compounds may cause irritation of the respiratory tract with symptoms such as coughing, pain in the chest, and possible pulmonary edema. Delayed gastrointestinal symptoms may also occur such as nausea, vomiting, colic and diarrhea. Chronic exposure of inorganic arsenic compounds may cause weakness, persistent headache, weight loss, fatigue, malaise, low grade fever,

salivation, and gastrointestinal disturbances with symptoms such as nausea and vomiting. Inorganic arsenic compounds have been shown to be lung and skin carcinogens in humans. Latency time between exposure and appearance of cancer is usually between 15 and 30 years.

Ingestion: Large doses of ingested arsenic or inorganic arsenic compounds may cause systemic poisoning with symptoms appearing one-half to four hours after ingestion. Symptoms may include burning and pain in the chest, esophagus, stomach and bowel, throat constriction, weakness, and a metallic taste. Other symptoms may include thirst, garlic odor to the breath and sweat, hot flushes, mental confusion, edema of the ankles, and nose bleeds. Less than lethal doses may cause delayed symptoms such as cold clammy skin, hypotension, shock, cardiac disturbances; death within 1 hour to 48 hours is usually due to circulatory failure. Damage to the liver and kidneys may occur. Chronic exposure by inhalation of inorganic arsenic compounds may cause effects similar to chronic inhalation.

Target Organs: Nervous system.

Medical Conditions Aggravated by Exposure: Diabetes. Heart or cardiovascular disorders. Immune system disorders. Allergies. Kidney disorders. Liver disorders. Nervous system disorders. Skin disorders.

Physical Hazards: Emits toxic fumes of arsenic and oxides of arsenic under fire conditions. Reaction with strong acid may release toxic arsine gas.

Additional Information on Fire and Explosion Hazards: Refer to Section 5, "Fire Fighting Measures" and Section 10, "Stability and Reactivity".

Listed as a Carcinogen/ Potential Carcinogen:

Yes	No	
X		In the National Toxicology Program (NTP) Report on Carcinogens.
X		In the International Agency for Research on Cancer (IARC) Monographs.
X		By the Occupational Safety and Health Administration (OSHA).

4. FIRST AID MEASURES

Skin Contact: Wash skin with soap and water for at least 15 minutes. Obtain medical assistance, if symptoms occur.

Eye Contact: Move victim away from exposure and into fresh air. Immediately flush eyes, including under the eyelids, with copious amounts of water for at least 15 minutes. Obtain medical assistance, if needed.

Inhalation: If adverse effects occur, move victim away from exposure and into fresh air. Get immediate medical attention.

Ingestion: Obtain immediate medical attention.

5. FIRE FIGHTING MEASURES

Fire and Explosion Hazards: This material is a slight fire hazard.

Extinguishing Media: Use dry chemical, dry sand, lime, or soda ash.

Fire Fighting: Keep unnecessary people away, isolate hazard area, and deny entry. Wear full protective clothing and NIOSH-approved self-contained breathing apparatus (SCBA). See section 8 for special chemical protective clothing.

Flash Point: Not applicable.

Autoignition Temperature: Not applicable.

Flammability Limits in Air

Upper (Volume %): Not applicable.

Lower (Volume %): Not applicable.

6. ACCIDENTAL RELEASE MEASURES

Occupational Release: Avoid heat, flames, sparks, and other sources of ignition. **Do not** touch spilled material. Wear appropriate protective clothing. Collect all material and transfer to an appropriate container for disposal. Prevent any release to drains or water or emission of dust or fumes to the air.

Disposal: Refer to section 13, "Disposal Considerations".

7. HANDLING AND STORAGE

Storage: Store and handle in accordance with all current regulations and standards. See the Certificate of Analysis for SRM 2841 for storage and handling of the product to protect product quality. Keep away from incompatible materials.

Safe Handling Precautions: See Section 8, "Exposure Controls and Personal Protection".

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

Exposure Limits:

Arsenic and Inorganic Compounds:

OSHA (PEL): 10 μg(As)/m^3 TWA
ACGIH: 0.01 mg (As)/m^3 TWA
NIOSH: 0.002 mg(As)/m^3 recommended ceiling (15 minutes)
WEL UK: 0.1 mg/m^3 TWA

Gallium Arsenide:

ACGIH: 0.0003 mg/m^3 TWA (respirable fraction)

Ventilation: Use a local exhaust ventilation system if significant dusting occurs.

Respirator: A NIOSH approved air purifying respirator may be used under conditions where airborne concentrations are expected to exceed exposure limits. A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed if workplace conditions warrant a respirator.

Eye Protection: Wear approved eye protection. An eye wash station should be readily available near the handling and use areas.

Personal Protection: Wear appropriate protective gloves and clothing to prevent skin exposure.

9. PHYSICAL AND CHEMICAL PROPERTIES

Component: **Gallium Arsenide**
Appearance and Odor: Solid. Dark grey with vitreous luster. Odorless.
Relative Molecular Mass: 144.64
Density: 5.31 kg/m^3
Water Solubility: Insoluble.

10. STABILITY AND REACTIVITY

Stability: ____ Stable X Unstable

Stable under normal temperatures and pressure.

Incompatible Materials: Reacts with strong acids to produce highly toxic arsine gas.

Conditions to Avoid: Excessive heating may cause emissions of toxic arsenic vapors.

Fire/Explosion Information: See Section 5, "Fire Fighting Measures".

Hazardous Decomposition Products: Arsine and oxides of arsenic.

Hazardous Polymerization: ____ Will Occur X Will Not Occur

11. TOXICOLOGICAL INFORMATION

Route of Entry: X Inhalation X Skin X Ingestion

Toxicity Data
Gallium Arsenide: Rat, Intraperitoneal LD_{30}: 10 g/kg
Rat, Inhalation-intermittent TC_{LO}: 100 $\mu g/m^3$ (6 h to 14 weeks)
Rat, Inhalation-intermittent TC_{LO}: 1 mg/m^3 (6 h to 16 days)

Gallium Arsenide has been investigated as tumorigenic and reproductive effectors.

Health Hazards (Acute and Chronic): See Section 4, "Hazards Identification," for potential health effects.

12. ECOLOGICAL INFORMATION

Adverse Effects: No ecotoxicity data available.

13. DISPOSAL CONSIDERATIONS

Waste Disposal: Dispose in accordance with all applicable federal, state, and local regulations.

14. TRANSPORTATION INFORMATION

U.S. DOT & IATA: Not regulated by DOT and IATA.

15. REGULATORY INFORMATION

U.S. Regulations: CERCLA Sections 102a/103 Hazardous Substances: Not regulated.

SARA Title III Sections 302, 304: Not regulated.

SARA Title III Section 313 (40 CFR 372.65): Arsenic and Inorganic Compounds (as As).

SARA Title III Sections 311/312 Hazardous Categories (40 CFR 370.21):

ACUTE:	Yes.
CHRONIC:	Yes.
FIRE:	No.
REACTIVE:	Yes.
SUDDEN RELEASE:	No.

OSHA Process Safety (20 CFR 1910.119): Not regulated.

California Proposition 65: Arsenic and inorganic compounds (as As) are known to the state of California to cause cancer (1987) and developmental toxicity (1997).

CANADIAN Regulations: WHMIS Classification: Not determined.

EC Classification:

T	Toxic.
N	Dangerous for the environment.

EC Risk and Safety Phrases:

R23/25	Toxic by inhalation and if swallowed.
R51/53	Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
S20/21	When using, do not eat, drink or smoke.
S22	Do not breathe dust.
S28	After contact with skin, wash immediately with plenty of soap and water.
S41	In case of fire and/or explosion, do not breathe fumes.
S45	In case of accident of if you feel unwell, seek medical advice immediately (show the label where possible).

National Inventory Status

U.S. Inventory (TSCA): Gallium Arsenide: Listed in inventory.

TSCA 12 (b) Export Notification: Not listed.

16. OTHER INFORMATION

Sources: MDL Information Systems, Inc., MSDS *Gallium Arsenide*, 16 March 2006.
Wafer Technology Ltd, *Gallium Arsenide*, 30 January 1997.